(Squibb)

DISINFECTANTS.

By E. R. SQUIBB, M.D.,

OF BROOKLYN, N. Y.

Consisting of an Article Republished from the Columns of the MEDICAL RECORD, Vol. I., Nos. 5 and 6, for May 1st and 15th, 1866; and a Report on Disinfectants made to the New York Academy of Medicine, and adopted by that body, May 30, 1866—the Report having been ordered by the Academy, at the suggestion of the Metropolitan Board of Health. Extracted from the Bulletin of the Academy by permission.

NEW YORK:

PRINTED BY THE NEW YORK PRINTING COMPANY,

NOS. 81, 83, AND 85 CENTRE STREET.

1866.

DISINFECTANTS.

Republished from the columns of the MEDICAL RECORD, *of New York, of May* 1 *and* 15, 1866.

THE approach of summer, the general necessity for sanitary reformation, and the possibility of Epidemic Cholera, have concurred in causing an unusual number of inquiries for disinfectants, and the writer, in his connexion with the manufacture of chemicals, has had a sufficient share of such inquiries to warrant him in offering some of his views upon the subject for professional and popular consideration.

The general question is, "What is the best, cheapest, most accessible, and most easily applied disinfectant?" To this there is but one answer, since there is but one agency through which all these indications can be fulfilled, and that is simple cleanliness. All other disinfectants are but slovenly substitutes, inadequate at best, and sometimes useless. When writing of disinfectants in hospitals, Miss Nightingale says, in substance, that the mortality is more favorably affected by the simple expedients which yield cleanliness and fresh air than by any other means, and that, with careful attention to these, none other agencies are required. Now cities, and countries too, are but large hospitals, with classification and localization of diseases; with some wards less healthy than others; and with the same imperative necessity for the only effective agencies, and the same penalties for neglecting them.

If the whole community could but be impressed with the truth, that cleanliness in body, in clothing, and in diet, and cleanliness and plenty of fresh air in and about dwelling-places, are the only possible conditions of security to general health, and the only real disinfectants, there would not be the same tendency to seek for and rely upon imperfect substitutes; nor occasion for all the writing and research upon such subjects At best, the so-called

sanitary science is but a system of cleanliness, and its prime utility consists mainly in the art of applying effective knowledge of this virtue which stands next to godliness, to the prevention and cure of general or epidemic disease. Like all other schemes of human construction, this art has its abstractions; and these tend to lead it away from the simplicity of its dependence upon cleanliness; and the complicated means by which results are often, if not generally sought for, have ingenuity, theoretical science, or some other form of advertisement, rather than practical utility to recommend them. Hence the various complex powders and liquids so much vaunted, and hence the question whether these are more effective than means far more simple and accessible. Each particular powder, liquid, and gas, undoubtedly has its special use in application to particular cases; but these cases are comparatively few, and of an individual character. None of these agents are adapted to general uses on the large scale, as affecting general health through the condition of the general atmosphere. Here the removal and prevention of filth,—that is cleanliness,—alone proves disinfectant, since it is the decompositions which occur in stagnant filth that give rise to the emanations which always lower the standard of health and often produce endemic disease. When filth can neither be generally prevented nor removed, then arises the only real necessity for some means of modifying or preventing the hurtful emanations therefrom, and this is the legitimate sphere of the class of what may be called artificial disinfectants, in contradistinction from the natural disinfectant, cleanliness. But to treat the emanations independent of their source, is like treating an effect without reference to its cause, and is not rational, though often useful. When Nature, through the operation of her laws, cries "Fire!" it is not good practice to bend our energies too much upon putting the smoke out. This relation of cause and effect, and the means resorted to under this relation, divides these means, namely artificial disinfectants, into antiseptics or disinfectants proper, which control the effect through the cause, and deodorizers, the principal though not the only effect of which is upon the emanations.

These emanations are always the results of complicated chemico-vital reactions of the nature of a fermentation, and these processes of fermentation appear to occupy that position in the great order of nature where the effects of vitality first begin to be seen to

modify chemical action. In the great field of the progressive creation this appears to be the daybreak of the morning of Life. Shrouded in its dim indistinctness, the primordial cell works its wonders in bending those laws which yield only to this mysterious principle of Life. Within the uncertain light of this misty domain, probably, lie the essential principles whose operation results in what we know as endemic and epidemic influences, contagion, and infection, leading to pestilence. In this initial stage of life the vital process is tender and delicate, and easily subjected to inscrutable modifications by atmospheric causes. Emanations which are sensibly the same even to the most minute scientific investigation, to-day are harmless, to-morrow become pestilential, and again are modified and controlled. All that is surely and practically known of these chemico-vital reactions is that they occur in the decay of organic matters which contain nitrogen by a process of oxidation, and that the results are always detrimental to human health and life. According to the extent and character of these reactions their effect may be general in lowering the general standard of health, and rendering all departures from health difficult of management, or may have superadded to this the further effect of producing endemic or epidemic disease of a special type. No more accurate definition of the word filth in its hurtful sense can be given than to say it is nitrogenized organic matter in the process of putrefaction; and, as the aggregate of this filth increases or diminishes, so the aggregate of human health and life is increased or diminished, since the reactions which naturally occur in the filth, although subject to some modification and control, are yet dominant and inevitable. Only in proportion, then, as the total absence of filth in communities of mankind is a theoretical abstraction never realized, does the value of means for disinfecting that filth increase, and hence the great importance of the present inquiry in regard to disinfectants.

Masses of filth in that condition of moisture and warmth which is best adapted to produce and continue the putrefactive fermentation, have their baneful activity varied by every variation of moisture and warmth, as well as by many other agencies, and hence every such variation has an important effect upon the causation of disease, and becomes disinfectant or otherwise in proportion as it checks or accelerates the putrefaction. Increase the moisture to the extent of copious dilution with water, and

the process is at once suspended, and the masses become for the time harmless. Diminish the moisture to ordinary dryness, and again the accumulations become temporarily in great measure harmless. Increase and diminution of temperature produce similar results, and if, on the one hand, carried up to about 180°, or on the other hand reduced to freezing, some of the most deleterious of the reactions are permanently arrested, and the processes must begin entirely anew.

Hence heat and cold even within the natural atmospheric limits exert very important influences; whilst artificially applied, as in steaming, boiling, baking, or freezing infected clothing or merchandise, they become, perhaps, the most powerful of all disinfectants available for such purposes. Heat, however, appears to be superior in its effects, as well as in facility of application; and although both destroy the fermentation and kill the acting generations of plants and animals, it is doubtful whether either the one or the other destroys the spores or seed from which succeeding generations may be produced.

The sensitiveness to external influences thus illustrated is a general characteristic of all the processes involved in these changes, and as a rule, all inorganic chemical compounds which are loosely held together; and all elements or compounds whose tendencies are towards further combination, interfere with or arrest these processes more or less permanently, and thus become disinfectants.

The prominent and essential characteristic of the putrefactive process is oxidation, and free access of atmospheric air is necessary to this oxidation; and yet the class of effective disinfectants comprises chemical agents of diametrically opposite action. As a rule, the value of a disinfectant chemical is determined by its power either to oxidize or to deoxidize substances with which it is brought in contact, and whether it does the one or the other seems a matter of indifference as far as disinfectant results are concerned. For example, chlorine, iodine, and bromine are among the most powerful and certain disinfectants, and act as such by the avidity with which their vapors combine with the hydrogen of the watery vapor of the atmosphere to form their respective hydrides, thus setting free the oxygen of the water in the form of ozone, and becoming powerful oxidizing agents. The permanganates also owe all their properties as disinfect-

ants to the large proportion of loosely combined oxygen they contain, and the facility with which they part with this to surrounding matters. Sulphates, as sulphate of iron, yield in the act of disinfection all their oxygen, and are reduced to sulphides, and are said not to be disinfectant at all if this separation of oxygen does not occur. On the other hand, among the most powerful of all disinfecting agencies known are the lower oxides of nitrogen and sulphur, whose tendencies are to abstract and appropriate oxygen from all sources capable of yielding it. Sulphurous acid and its salts are particularly effective, and when these have accomplished their rôle as disinfectants, they are found to have been converted into sulphuric acid and sulphates by an increase of their proportion of oxygen abstracted from the matters with which they have been in contact.

This contrariety in the essential chemical character of the most effective disinfectants cannot be explained in the present state of knowledge. It may be, however, that these delicate and sensitive processes and reactions are susceptible of being as easily arrested by over oxidation as by deoxidation, and that the presence of the resulting chemical compound may poison the pabulum against a recurrence of the same set of phenomena. It is a curious fact, having a very important bearing upon this whole subject of the causation of endemic and epidemic insalubrity, that although the admixture of powerful corrosive and deadly chemicals always destroys the existing generations of the microscopic plants and animalculæ which play so important a part in these fermentations, yet such admixture seems sometimes only to have better adapted the soil and climate to another set of creatures, and the masses soon have a new order of animated nature. Whether these orders of life are alike in their tendency to insalubrity or not, or whether a particular order gives rise to particular epidemic diseases, or conditions tending to a particular type of disease, are questions of much significance and importance. The spores, or seed and ova, of all kinds and qualities of plants, animalculæ, and of their connecting links, seem to exist everywhere, and each kind or order requires but its appropriate pabulum to develop it into active existence. Just as the agriculturist, by slight modifications of his soil alone, without seeding, does, at will, produce different vegetable species; or, for a still better illustration, as the Neapolitan gardener takes the scoria which has but recently been sub-

jected to igneous fusion in Vesuvius, and by simply watering it gets from it a crop of edible mushrooms; so a set of natural phenomena, each in itself but a partial and inactive cause, finally concur in some locality, and, at some time, in their conjunction, produce that condition necessary to start the train of hurtful decompositions and fermentations. Thence, from an established starting-point, the propagation is comparatively easy, and the increase is a geometrical progression until the whole pabulum of a city or of a nation may be invaded. A familiar example of this process is afforded in the making of fermented or leavened bread. It requires time, skill, and careful selection of proper materials to make the ferment or leaven afresh; or, in other words, a certain conjunction or concurrence of material, of moisture and of temperature, are absolutely requisite, as a pabulum or matrix, for developing the first generation of cells of the yeast plant from the spores which are floating about in the air, or present always in the materials. But a single generation, or even a single cell once developed, the propagation is easy, and the increase vigorous and rapid, even in pabulæ not so accurately adapted to the process as the first had to be. Hence, a very small portion of this ferment or yeast incorporated with a large mass of dough, and subjected to a moderately well-adjusted temperature, soon sets the whole mass into this same condition, so that a small portion of the mass mixed with another large portion of dough, communicates to it the same tendency to the same fermentation, but to no other variety of fermentation. But now, if a portion of the dough in this fermenting condition be frozen or baked, the process is not only arrested, but is destroyed, and hence baked bread, by being kept in a moist warm condition, is much more prone to undergo a new process of fermentation—namely, the acetous or putrefactive, than to take up again that particular fermentation which was destroyed by the heat in baking. Each one of these particular ferments—and the number already known is large—requires not only its particular matrix for its primary development into activity, but has the property of so exhausting or consuming its particular food in the matrix, that it becomes self-limiting in any given amount of matrix, and requires constant accessions of new material for its perpetuation; and a matrix once exhausted by a given ferment, or even partially exhausted, if the process be arrested, although left full of the

spores of the first, is prone to undergo another and different fermentation, yielding a totally different set of products. That is to say, the reactions which occur in one natural order of phenomena are exhaustive, and the new conditions established by this exhaustion are thereby adapted to a new order. The soil and climate adapted to the yeasty fermentation are exhausted and impoverished by the plant, but are thus the better adapted to the starting of a new fermentation, and the sustenance of a new order of living beings. That is, the ferns and pterodactyls of a carboniferous era of these microscopic worlds have their soil and climate so modified by the natural order of changes, in which themselves play so important a part, that after a time their fossil remains only are left for the contemplation of succeeding orders and ages.

Such examples apply equally to the orders of successive creation upon the whole surface, through all the geological history of the terrestrial globe, and to those in the pile of filth at our doors. Time and space, so wonderful to us, have unknown relations to those laws which govern with the same unerring control the solar system and the microscopic cell.

These illustrations are particularly intended to show, first, that the best, if not the only way to prevent pestilential fermentation is to prevent the formation of, or to remove, that pabulum which is essential to the process, namely filth ; and, second, as abstract cleanliness cannot be at once attained, if at all, in communities like this, to show by what kind or character of agencies these hurtful reactions must be controlled. They also show that many of these reactions are so delicate and sensitive in character that they may be modified, suspended, or even destroyed, by a great number of agents—indeed by almost everything which materially modifies the condition of the pabulum. The principal difficulty, then, consists not in the selection of a disinfectant, since all are effective, even the most opposite in character, but rather in the adéquate application of a process of disinfection; for once started, with a widely diffused pabulum that is always receiving new accessions, the fermentation increases and spreads with a rapidity that soon leaves the best directed efforts at general disinfection far behind. Any disinfectant then becomes useful in proportion to the scale upon which it can be practically applied; and such application depends largely upon the simplicity, cheapness and

abundance of the agent, particularly in time of epidemic disease. Except for individual and special uses, and these in the houses of the better and more cleanly classes, where perhaps they are rarely needed, a large class of the most active agents, as bromine, permanganates, etc., are out of the question; while even chlorine, the sulphates of iron and copper, carbolic acid, and the patented powders and liquids, taken altogether, fall far short of the desirable universality. Archimedes, to move the world, must have a long lever as well as a strong one.

In coming to the consideration of the prominent special agencies for disinfection, in special as well as general cases, it is well to remember first, that:

A plentiful supply of water and air, and a good system of sewerage and drainage as inducements to cleanliness, and a good police, directed with knowledge and armed with power, must always be regarded, and can alone be considered as effectually disinfectant for cities. But such police, as well as the private citizen, will often need auxiliary means for special cases and purposes, as well as for general and public use; and their auxiliary and secondary character should never be lost sight of. It may be regarded as a sanitary axiom that natural disinfection, whereby the greatest practicable cleansing is attained, should always precede every attempt at artificial disinfection. Then the greatest cleanliness having been attained, and the special purposes accomplished by the special agents, the field of application for the general disinfectants is narrowed within its most practicable and most manageable limits. These principles of disinfection established and borne well in remembrance, it can only be necessary to refer in a cursory manner to the newer applications of one or two of the special agents, and then merely to enumerate others, somewhat in the order of their importance, in approaching the main object of the paper.

For a very nice use in disinfecting and deodorizing the air of a sick-chamber, where the odor of other gaseous disinfectants would be more objectionable, a well-regulated elimination of ozone, by means of phosphorus, may be resorted to with success.

A stick of phosphorus, or half of a stick for an ordinary chamber, laid upon the flat surface of an ordinary tea or breakfast plate, and water enough poured upon the plate to immerse two-thirds of the stick, leaving the remainder exposed to the air; and the plate then placed upon a table or mantel-piece out of the reach of acci-

dent or disturbance, and yet where it is under constant observation, constitute the materials and conditions proper to accomplish this. That portion of the phosphorus which is immersed, undergoes no change, and produces no effect; and therefore the effect to be produced may be easily regulated by adding and abstracting water, and thereby exposing more or less of the phosphorus to the moist air. For example, in a sick-chamber during the day, where the opening of doors and the movements of attendants tends to greater disturbances and change of the air, the cylinder of phosphorus may be left one-third or more exposed above the surface of the water, at least until the odor of phosphorous acid becomes disagreeable. Then at night, when the chamber is to be closed and still, more water is poured upon the plate, until perhaps but a line of the cylinder is exposed above the surface. By morning the evaporation of the water will have increased the amount of surface exposed; but if not sufficiently, some of the water may be dipped out of the plate to produce the increased daytime effect. When the desired disinfection has been accomplished, and the action is to be suspended for a day or two, the simple filling the plate up with water until the whole stick is immersed, accomplishes that end. In the dark the exposed portion of the phosphorus shines, casting a somewhat lurid light around the apartment, and the vapors arising from it are visible and moving. This latter effect particularly should be hidden from the view of the patient, since, whether there be a tendency to delirium or not, the half-sleeping mental condition of most sick persons is very impressible, and may be injuriously affected thereby. Phosphorus, from its easy inflammability, is a dangerous substance at best, and therefore this means of disinfection is never perfectly safe, and can only be judiciously adopted under the direction of a medical man who will take the time to think what he is doing, and the pains to give proper directions and cautions, and who knows the responsibility and risk which he assumes. An accident by which the phosphorus, whether in buying it, using it, or in keeping for after use, may be allowed to become dry, will result in its spontaneous combustion, and in setting fire to anything which may be near it; whilst a small particle even, taking fire upon the skin, makes the worst variety of burn, and risks setting the clothing on fire. It should always be kept in water, and when not in use, in a bottle wholly immersed. When acidentally thrown from the plate or dropped

from a broken bottle, it may while wet be safely picked up with the fingers and replaced in any vessel of water at hand; but when it has been out of the water long enough to become dry, it should never be touched until it is remoistened, and the hand that touches it should also be wet. In common with all other means of deodorizing, this is very apt to be overdone, particularly since it does not, like most others, become unbearable by its odor, and thus give notice. Ozone in the atmosphere in large proportion is noxious; and even in the proportion which may be obtained by mismanagement of this process, it is capable of producing disagreeable, if not injurious effects. One of the first evidences of its presence in undue proportion is a congestion of the mucous linings of the air passages, causing that dry, uncomfortable feeling about the posterior nares and fauces so well known in the commencing stage of catarrh. It is not supposed to be possible, however, so to mismanage the process above described as to render it dangerous, or even seriously injurious from this cause; neither is it supposed that enough phosphorus vapors could be introduced into the air of apartments to produce phosphorus disease of the bones. Its use as a deodorizing disinfectant should always be regulated with care, and with judgment be adapted to the desired effect. It will then rarely, if ever, be continuously required, no matter in how small quantities the ozone may be liberated; but by intermittent use, say for twelve or twenty-four hours, once or twice a week, will accomplish all that could be expected from it. Judiciously used, therefore, this will be found the most effective, as well as the most simple, neatest, and cleanest of all similar means; whilst the phosphorous acid which it incidentally introduces in very minute proportion into the air, has less odor, and is less irritating and more healthful in its effects than the corresponding products of the other similar agents.

Next to this in practical efficiency for such special uses, stands chlorine, which, if slowly liberated in the small quantities really required for these uses, is hardly objectionable to the most delicate condition, and certainly never hurtful, whilst it is thoroughly effective and perfectly safe in use. It, however, requires careful and judicious management, and a moderate degree of attention and knowledge to secure these results and avoid overdosing. In use it is less liable to be overdone than the method last mentioned, because the odor is so irritating and disagreeable as to secure a

proper correction. It is best liberated from a finely ground mixture of common salt and binoxide of maganese, by means of cold diluted sulphuric acid, and these materials for generating it are put up in packages by many manufacturers, with plain, simple directions for use.* In this form, though not very expensive, it is more so than the phosphorous method, but is safer in its management, whilst the residue from its use is admirably adapted to correct the fetor and destroy the poison of excretions.

About 200 grains of the common salt mixture and half a fluid ounce of the sulphuric acid mixture liberates in the course of twelve or twenty-four hours about fifty cubic inches of chlorine, giving it off pretty rapidly for the first two or three hours, and very slowly afterwards. Now, if these materials be mixed in the bed-pans or close-stools of a chamber or ward, and be allowed to stand until these vessels come to be used for receiving the excretions, the air of the apartment, the neighborhood of the bed, the vessel itself, and, finally and most important of all, especially in connexion with some late vews in regard to the propagation of cholera by or from the de-

---

* This, the best method of liberating chlorine without heat, is that of the German chemist Wiggers, and his formula is as follows (Fresenius, Qual. Analysis, Eng. Ed. 1859, p. 28):—"Mix 18 parts of finely ground common salt with 15 parts of *finely pulverised* good binoxide of manganese; put the mixture in a flask, and pour a *completely cooled* mixture of 45 parts of concentrated sulphuric acid and 21 parts of water upon it, and shake the flask; a uniform and continuous evolution of chlorine gas will soon begin, which when slackening may be easily increased again by *gentle* heat."

This excellent method was adapted to disinfectant uses in hospitals, with directions for the preparation of the materials, and for use, by the writer of this paper, some years ago, for army use. And throughout the war it has been very largely used. Through this large use it has now become an article of common trade, and is doubtless easily accessible, in all the larger cities at least. There is neither secrecy, complexity, nor other difficulty in connexion with it. Any tyro can prepare it from the very beginning. The materials are made and sold by most manufacturers, put up after the plan used for the army, as follows: A large pasteboard box contains in one end a pasteboard drawer, in which are placed 130 packages, each containing about 195 to 200 grains of the common salt mixture. The remainder of the box is occupied by a strong half-gallon-bottle, containing the sulphuric acid in due proportion to the number of powders. The bottle and box both bear labels explaining the composition and mode of preparing the contents, with simple directions for use. Besides this, the powder and acid mixture are both supplied in bulk by manufacturers for use in hospitals, etc.

jections, these latter are all thoroughly deodorized and disinfected. This residue, thus susceptible of being so efficiently utilized, holds a considerable quantity of chlorine in solution; but, besides this, it contains the sulphate of the protoxide of manganese, which results from the process by which the chlorine is liberated; and this, with the sulphate of soda and the excess of sulphuric acid used, happen all to be very effective disinfectants. The force with which the dejections are discharged into the vessels will not be sufficient to stir up the thick residue (which should have been previously spread or rinsed round over the bottom of the vessel), and therefore the stirring should be done with a short stick before the contents are thrown into the cesspool or sewer pipe; and then, when the vessel and stick are rinsed out and returned to their place, a new portion, or, if the dejections are frequent and small, half a portion, is to be at once mixed in the vessel, using this same stick to stir the mixture with, and leaving it in the vessel until the moment the next dejection occurs. It is then taken out by the patient or attendant, and held till required for that occasion. Some such management in the cases of cholera dejections, would most thoroughly disinfect them, and would probably disarm them of all hurtful tendency, and at the same time keep the cesspools and sewer pipes in an improved condition, since the more frequent the dejections the more frequently would these latter receive the chlorine residues. And, in hospital practice, the more active the disease (cholera for example) might be, the more active would be the disinfection, both of the atmosphere of the ward, and of the sewers, waste pipes, etc. When to be used in this way, on the large scale, the common salt mixture or brown powder would be dispensed to a ward in tin cans, containing say five pounds each, with a little tin ladle adjusted to hold between 195 and 200 grains when filled and struck off level with the edge by means of a spatula or other contrivance used to fill the ladle with; and the sulphuric acid mixture would be dispensed in bottles holding say half a gallon, and accompanied by a small graduated measure or other means of measuring half a fluid ounce. In this way the expense of the plan is very much reduced and the application facilitated and extended, since in large quantities the common salt mixture would not cost over thirty cents per pound, including the tin can; and the sulphuric acid mixture not over eight cents per pound, exclusive of the bottle.

Bromine is an excellent disinfectant, and evaporates spontaneously and so rapidly that the simple removing the stopper from a narrow-necked bottle of it in an apartment will soon deodorize the atmosphere, and if the room be warm will become irritant. Like nitrous and sulphurous acids, however, it is very difficult to manage without becoming either inefficient or irritating, whilst it is an expensive and corrosive liquid, so volatile and irritant that an ounce of it accidentally spilled in a chamber would render the air dangerous to life. Like chlorine, iodine, etc., its activity as a deodorizing disinfectant depends upon its union with the hydrogen of the watery vapor of the atmosphere to produce hydrobromic acid, setting the oxygen of the water free in the form of ozone probably.

Chlorinated lime, or, as it is commonly miscalled, chloride of lime, and creasote and carbolic acid, also partake somewhat of the character of gaseous disinfectants or deodorizers, or at least occupy the intermediate ground, partaking of the nature of both gaseous and solid disinfectants, and are all available and effective for many special purposes. Creasote and carbolic acid, as well as the coal-tar from which the latter is separated, are all powerfully antiseptic, and possess the singular property, not only of arresting the putrefactive process, but also of preventing its recurrence, and of destroying the lower orders of living beings which belong to or result from these fermentations. So long as it remains in the pabulum it seems to defend it against all attacks of the nature here considered; but it so happens that it is itself easily decomposed through reactions of a purely chemical character, and its effects are thus somewhat limited.

The creasote of the present day is nearly, if not all of it, a mere impure form of carbolic acid; and as it is equally available with the latter for all these purposes, and cheaper, as well as more generally accessible, it is perhaps best adapted to the special uses now to be briefly noticed. Common commercial creasote is soluble in about the proportion of one fluid drachm to ten fluid ounces of water, by shaking them together in a bottle. But a better solution for burns and scalds, as well as for disinfectant purposes, is one fluid drachm (or a teaspoonful) to a pint of water. Such a solution made in quantity does not cost over one cent per pint, and is particularly applicable to hospital uses. This is the Aqua Creasoti or creasote water of the U. S. Pharmacopœia, which

should always be at hand where burns and scalds are liable to occur. For dressings and many other of the uses to which it is specially applicable, it may be still further diluted at the time of application. As an occasional wash to unhealthy sores; as a dressing (out of contact if the surface be irritable) to suppurating injuries, particularly in warm weather; as an addition to the rinsing water for sponges, bandages, oiled cloths, napkins, clothing, etc., which have been or are to be used about sores; as a wash to sponge off the top of bedside tables, chairs, etc.; and, in short, for profuse use in general about sick or bedridden persons and their appurtenances and dejecta, it is one of the most effective agents yet known, and has the great advantage of simplicity, safety, cheapness, and easy accessibility. In common with all other agents, however, it requires intermissions in use, and, after a time, may with advantage be substituted by agents far inferior to it in antiseptic power. Besides, it has a most persistent, strong, and disagreeable odor, which often, though tolerable at first, becomes so offensive as to be injurious. It is hence better adapted to hospital than to private uses, except where in the latter cases the odor to be corrected and prevented is worse than that of the agent, as, for example, in many cancerous diseases.

Permanganates in solution are very efficient antiseptics. They are not volatile, and therefore odorless and antiseptic only; that is, they do not at all affect existing effluvia in the air, except as the effluvia are brought in contact with the solution. As washes and as dressings for sores, they are, as commonly prepared, more irritant than creasote water; whilst for the purposes of disinfecting sponges, bandages, etc., they are not applicable. For injections, as in cancerous disease of the uterus, they are, when free from caustic alkalies, specially well adapted, and frequently odors may, by their use, be prevented at their source, which have rendered chambers, or even entire dwelling-houses, offensive. Although safe, and of easy application, the solution requires careful adjustment to each case when used as injections, or as topical applications to avoid caustic or over-stimulating effects, and these solutions must be kept carefully out of contact with organic matter, since they are easily and rapidly decomposed thereby.

The permanganates are complex compounds, the purity of which is important, and not easily judged of by appearance, whilst they are, besides, expensive, and not generally accessible.

Solutions of sulphite and hyposulphite of soda; of the chlorides of zinc and iron; of both the sulphates of iron; of the nitrates of lead, zinc, and iron; and, indeed, of a very large number of other chemical substances, are all efficient antiseptics or disinfectants, and may each be used as specially adapted, or when specially accessible, to some purposes or conditions. All fulfil the prominent indications of most conditions, but not in like degree, nor with equal convenience in all.

The same may be said of the various patented and self-lauded powders and liquids, all of which are more or less complex compounds of the well-known agents referred to in this paper, mixed with absorbent powders, and generally managed so as to fufil the first and prominent indication to their use—namely, to make money. The well-educated physician, acquainted with proper authorities, can no more be satisfied with a single article or compound to subserve all his purposes as a disinfectant, than he can with a single drug or a single prescription with which to treat all his conditions of disease; and patents and patented articles in the medical science and art are but clumsy, slovenly, undignified, illiberal substitutes for knowledge, which involve concealment and deception, and very often mask active and injurious ignorance.

One remark deducible from the character of the processes involved in the necessity to disinfect, may be useful as applicable to all means of special disinfection—namely, that the agents should be occasionally changed or intermitted. For example, a suppurating surface may be so long dressed with creasote water that, although one particular class of reactions is prevented, those of some other class may be called into activity or fostered, and such may have a like tendency to interfere with the reparative processes of nature. This is but another application of that well-known experience in surgery which indicates occasional changes in the character of dressings, no matter how simple or effective they may be at first. Again, a chamber or hospital-ward may be much more easily rendered injurious to the inmates by the uninterrupted use, month after month, of any given gaseous disinfectant or deodorizer, even the very best, than if an occasional change or intermission be made.

We now come to the prominent object of this paper—namely, to endeavor to show, in view of an apprehended invasion of

Epidemic Cholera, that there are, within easy reach and in great abundance, two simple agents which are as thoroughly, as promptly, and as surely disinfectant, for general uses, as the nature of the infecting agencies will admit of in the present state of knowledge; and that, by the exercise of a reasonable amount of skill, judgment, and forethought on the part of the medical profession and the educated classes of the community, these agents may be made eminently useful, and all-sufficient as adjuncts to the greatest attainable cleanliness. In the two common substances, charcoal and lime, may be found agents which, for general disinfectant purposes on the large scale, leave little to be desired; since, used together or alternately, they fulfil more of the indications, and do it better, than any other simple substances. No new evidence of this can or need be adduced, since to collect and epitomize the knowledge upon the practical use and value of these agents as disinfectants would far exceed the limits of this paper. The tendency is, however, so great to overlook simple agencies which lie at our doors, and to forget the accumulations of knowledge which have lost the charm of novelty, as to justify, if not to demand, a review of a few of the prominent qualities upon which the utility of these agents depend, with a view of recalling attention to them at the present time of need.

Charcoal, the more freshly made the better, absorbs, under ordinary circumstances, say fifteen or twenty times its own volume of all the hurtful vapors and gases eliminated in the putrefactive process, and attracts with much promptitude such vapors from the atmosphere around it. All such vapors are held permanently in its pores, and some are decomposed by it into more simple combinations. Partial, or even entire saturation with one gas, does not prevent the absorption to a very considerable extent of others; and these absorptions and decompositions by the charcoal go on for two or three weeks, and in the case of some gases longer. Upon this absorption, condensation and decomposition of gases and vapors and upon its antiseptic properties of preventing and arresting the putrefactive process, which must precede the development of the lower orders of organic life, and the elimination of noxious effluvia, does charcoal mainly, but not entirely, depend for its efficacy as a disinfectant; and no substance, whether simple or compound, rests upon a better foundation, or covers a broader ground. The conditions adapted to its

maximum efficacy are its either being freshly made or well kept, and being in a state of coarse powder, and these for obvious reasons; and yet the fine and comparatively worthless residue from kilns, and receptacles where it is kept in large quantities, is very effective as a disinfectant. An ordinary house-pailful of this thrown over the surface of the contents of a privy sink, or cesspool, once a week, or even once in two weeks, especially if alternated with lime, will first, by covering the surface, lessen the atmospheric contact necessary to carry on the processes by which effluvia are produced; second, by extracting moisture from the surface with which it is in immediate contact, will form a crust in which both the chemical and vital processes are obstructed, and which crust partially seals up the masses beneath, allowing the fluid portions to drain off undecomposed into the earth; third, by forming a filter upon the surface, through which all emanations from below must pass before they can become noxious, and thus filter them out; and fourth, by forming a partition between the fermenting mass below and the new accessions from above, and by absorbing and fixing the latter, it will tend to prevent extension of the process, and allow the masses below to be smothered out and exhausted. The applicability illustrated in this single example of its action and uses can be easily extended and adapted by common sense to the various other general purposes for which such agencies are required. Charcoal is produced all over the world, and is easily and cheaply obtained in sufficient quantities almost everywhere; and almost any mill, however crude and simple, will grind it rapidly into the coarse powder most available for disinfectant purposes.

Lime,—ordinary quicklime,—produces mechanical and chemical results equal, if not superior, to those of charcoal, but of a character so different as to render a judicious combination of the two better than either alone. It has been shown that the primary character of all the putrefactive processes is one of oxidation, and that the atmosphere as a source of oxygen, under certain conditions of moisture and warmth, is indispensable to this particular oxidation. The results of this oxidation are a set of oxides, liquid and gaseous, generally of either an acid or an oily nature, and to these are superadded the lower orders of organic life. Now lime is a prompt and active caustic alkaline substance. It combines chemically and greedily with its weight of water, and with

sixteen hundred times its volume of watery vapor without losing its solid and apparently dry condition. In absorbing this large proportion of watery vapor, heat is produced in sufficient amount to cause an active circulation of the atmosphere around the lime, and if the supply of moisture be sufficiently rapid, the heat will be sufficient to entirely destroy the process of fermentation. Again, in absorbing this large proportion of watery vapor from the atmosphere around it, of course all the gases, effluvia, spores, etc., of which this aqueous vapor is the solvent or carrier, are absorbed with it, and subjected to the destructive action of its caustic nature. Now one cubic metre of atmospheric air, equal to, say twenty-eight cubic feet, when saturated with moisture holds about 140 grains, but occasionally contains as little as 14 grains. The same volume of air contains, under varying conditions, from 7 to 12 grains of carbonic acid, the average being about 9.4 grains; and of organic matters chiefly carried by the aqueous vapor, the variations will range from one-quarter of a grain up to 800 grains, the general average, however, being from 1 to 1.5 grains. The other gases and vapors are in much smaller proportion, and besides, are supposed to be less noxious. An ordinary dwelling-house apartment contains about one hundred times this volume of air, and will therefore contain an average of say 3,500 grains of water and 940 grains of carbonic acid, and 150 to 200 grains of organic matter. Now, to deprive this volume of air of one-fourth part of its noxious impurities would be to change it from the greatest ordinary general insalubrity to a healthful condition; and this would be easily accomplished within the practical working capacity of a quarter of a pound of lime within forty-eight hours. The lime not only combines chemically with all acids and acid vapors, as well as with the water that carries them, but it also combines with all oleaginous matters and products, fixing them into permanent, solid, and generally insoluble combinations, no matter whether the oleaginous matters be rancid or not. As a caustic alkali, it, in common with other chemical substances, poisons the pabulum of organic life, and by its slow and difficult solubility it remains in these pabulæ longer than any of the more soluble chemicals, and thus goes further in effect. Besides this, as a caustic it destroys the delicate cell-walls of organic life, and coagulates their albuminous contents. In the form of coarse powder, either alone or mixed with char-

coal, it is thus applicable to many of the uses of a general disinfectant; whilst in the form of whitewash it offers another series of useful applications, scarcely less important and equally simple.

In purifying and disinfecting human habitations, almost everything may be whitewashed in an emergency; and in the application to floors and other wood-work, whether painted or not, and even to articles of furniture, it permeates cracks, fissures, and spongy surfaces, which can be cleansed and purified as well in no other way, whilst it may be washed off from surfaces to which it is not permanently appropriate with the certainty that in once drying on, its office has been performed.

An empty tenement-house or other infected building, once or twice well filled with wood-smoke from a fire made in the cellar, and then well whitewashed all over, will probably be as perfectly disinfected as it could be by any other means whatever, and certainly as easily and as cheaply. The smoke carries creasote, charcoal, acetic acid, and carbonic oxide and acid, with aqueous vapor enough to dissolve and diffuse them, and with these penetrates all spaces, even the dark and hidden abodes of the cryptogams otherwise inaccessible. The temperature of the smoke very much aids the laws of diffusion, by which its gases and vapors are rapidly disseminated equally throughout the whole space and brought in contact with all the surfaces and recesses; and this temperature also increases the carrying capacity of the smoke by which its solution of creasote and carbonaceous matter is firmly held until condensed by contact with the cooler surfaces. Smoke thus has some penetrating and pervading qualities not possessed to the same extent by other gaseous disinfectants. After such smoking a general, thorough whitewashing completes the effective process.

From this brief review and illustrations, it may be seen that it would be difficult to conceive of two agencies which, together, would better cover the whole ground involved in this subject of general disinfection, or two which are so universally accessible, so easy of application, so safe, so simple, and so cheap. Lime may, like charcoal, be ground fine enough for disinfectant purposes by almost any kind of a mill, however crude; but ordinary plaster mills are perhaps best adapted to the work. In the absence of a mill of any kind, it may be reduced to powder by sprinkling upon it from one-fourth to one-half its weight

of water. This partially slakes or hydrates the lime, and to a proportionate extent impairs some of its qualities as a disinfectant. But, as in common with charcoal, it possesses these qualities in so great excess over most other agents, it can afford this impairment and still be very effective, even in absorbing aqueous vapor. But besides, when saturated with water or thoroughly slaked, it is still in powder very useful, since its capacity for acid vapors, etc., is rather increased than diminished thereby. It follows from this that as whitewash it has little or no effect upon the aqueous vapor in the air, and its action on the gases which the air contains is here entirely independent of the absorption of the aqueous vapor. But the extended surfaces to which it is usually applied so increases the contact from a given quantity of lime, that it is probable that four ounces of lime spread as whitewash upon the walls of a chamber would abstract more carbonic acid from the air in a given time than a pound of the same lime in powder contained in a shallow box upon the floor. To sum up, therefore, it may be confidently asserted that lime as a powder, to be strewn over dirty, damp places, or upon the surface of the contents of privy sinks and cesspools, or for use in water-closets, garbage receptacles, etc., in connexion with charcoal or alone; and in the form of whitewash to be spread over broad surfaces, including floors, gutters, alleyways, etc., and especially when this is frequently repeated, is a most efficacious and important disinfectant, if not the best of all such.

Freshly prepared lime and charcoal in the proportion of about two parts lime and one part charcoal, ground together into coarse powder, and the powder at once securely packed in barrels for use, could probably be obtained for about three dollars per barrel in large quantities; and such powder would fulfil all the indications to the use of both agents, and would constitute as good a general disinfectant for all the various uses in the form of dry powder, as could be produced in the present state of knowledge; and if the communities would accept the accumulated evidence of character, and settle down upon the use of this which everybody could prepare and sell cheaply as a common merchandise, the greatest general good attainable would be likely to result. Such a compound might be appropriately called "Calx Disinfecting Powder," or briefly, "Calx Powder," and be sold by pharmaceutists in arbitrary packages or by the pound at a low charge.

This, with the common "chloride of lime," would then be generally available, and would subserve all the popular ends.

In many cases common recently calcined plaster of Paris, or "plaster," as it is technically called, forms a good disinfectant, acting however wholly as an absorbent. Mixed with the contents, or with the surface contents of privy sinks, cesspools, etc., it solidifies them by abstracting the water, and "setting," as it is termed—thus in a measure arresting the processes and fixing the effluvia. Mixed quickly into a thin paste and quickly applied to cracks and crevices about the covers of cesspools and other sources of offensive effluvia; and applied thus as a cement or plaster for sealing up sinks, cesspools, etc., after having been emptied, or to secure them against doing harm during warm weather, or under other circumstances which prevents their being emptied or cleaned, this often subserves very useful and important purposes, setting as it does into a hard cement.

BROOKLYN, April 25, 1866.

REPORT ON DISINFECTANTS.

WITH SPECIAL REFERENCE TO THE PREVENTION OF

EPIDEMIC CHOLERA.

[Ordered by the New York Academy of Medicine, at the suggestion of the Metropolitan Board of Health, and adopted by the Academy May 30, 1866, and ordered to be printed.]

(*Extracted from the Bulletin of the Academy by permission.*)

To Dr. John C. Draper, *Chairman*:—Conforming to your request, I beg to submit my views in regard to the best and cheapest disinfectants adapted to general use.

It is not the object of this report to embrace the principles involved in disinfection, nor a consideration of all the important disinfectants; but merely to epitomize, in a practical form, the knowledge of a very few of them; knowledge which is easily and equally accessible to all mankind, though possessed by your reporter to a limited extent only.

For some generalizations upon the principles involved in disinfection, and some account of a few disinfectants not to be alluded to here, as well as for some other matter in relation to this subject and not reproduced in this report, your reporter begs to refer to an article written but a short time since, and to be found in the columns of the *Medical Record* of New York, Vol. I., Nos. 5 and 6, for May 1 and 15, 1866. The first part of that paper was already published, and the second part in type, when your reporter was notified of his appointment to your committee, and the duty assigned to him of presenting this report.

It can never be wholly useless to reiterate and reaffirm on every proper occasion the most important truth connected with this whole subject, namely: that cleanliness and ventilation are the only true disinfectants; and that just in proportion as these are attained, all other disinfectants lose their importance.

But leaving these, the only true disinfectants, out of the question, we still have the common acceptation and scope of the term left; and disinfectants in their common acceptation,

and that which is to be their meaning in this report, may be defined to be slovenly substitutes for cleanliness and ventilation, which possess the power in various degrees of rendering filth or uncleanliness less noxious. These substitutes must vary in character with the forms and conditions in which the uncleanliness presents itself, and hence it is probable that no two agencies are equally applicable to the same use. It is, therefore, the proper selection and application of a known means to a given end, rather than the finding out of new means, which forms the proper study in connexion with this subject.

There is, however, one general agency, which in efficacy, universality, accessibility, versatility of application, and harmlessness, may be regarded as the greatest disinfectant known, namely, heat. The new light and force given to the views of Count Rumford and Sir Humphry Davy, by the researches of the present time, upon the nature of heat and motion, render it probable that heat is the only agency that is disinfectant at all. Or, in other words, that abstract cleanliness once departed from, is only recovered through the agency of heat. This view would explain how it happens that active oxidation or deoxidation is equally disinfectant. All reactions, physical, chemical, and vital, are the result of, or result in heat or motion; and as these are now shown to be convertible terms—or rather two expressions of one and the same agency, therefore every action in which this agency is involved, namely, the operation of every natural law of the universe upon every other natural law, bears through it an intrinsic reciprocal relation. The wide scope of this field, or this train of thought, however, is not adapted to the intended character of this report, and hence heat as a disinfectant was entirely omitted from the first draft of this report submitted to your committee, though not from want of a due recognition of its importance. This brief and inadequate allusion is introduced at the suggestion of your committee, and may be concluded by simply adding that the empirical use of heat as a disinfectant was discovered and applied very long ago. How long, it seems now impossible to tell. The first application of heat in this direction met with, in the reading of your reporter, that can be now recalled, was that by M. Appert, translated into English in 1812 ("The Art of Preserving all kinds of Animal and Vegetable Substances for several Years"). The more special use of heat as a sanitary disinfectant, seems to have originally grown

out of its use long ago for destroying the insects and eggs in various insect plagues, and particularly in lousy clothing. It appears to have been known as destructive of the itch contagion by clothing before the acarus was demonstrated in 1812, and it has gradually and empirically grown up to its present rational application, where its claims have been so often and so ably illustrated among us that it can gain nothing at the hands of your reporter.

The cold of a freezing temperature renders the processes involved in the causation of zymotic and epidemic diseases latent and harmless, and a thorough disinfection appears to have resulted from the use of ice. Yet it is considered doubtful whether the effect of cold ever does more than suspend the activity of the causes of infection. The effect of heat, however, is unequivocal. A temperature of 150° is said to be sufficient to destroy the insects and ova of the pediculus and acarus affections (Aitken), whilst 200° is required for the destruction of scarlatina poison (Henry). As, however, few of the articles of common usage are injured by a boiling temperature (212°), this, whether applied dry or moist, seems to be practically adopted as the lower limit of security and safety. Both dry and moist heat have their special and equally important applications, and any advocacy of either to replace the other in general applicability, partakes of the irrational character of too many of the theoretical abstractions of the present day. The use of scalding water or steam, as an application of heat to soiled clothing, which may be cleaned but not materially damaged thereby, is too plainly indicated to admit of question; and the same may be said of the application of dry heat to bales of dry-goods, and most other merchandise that is capable of propagating disease. But whether any such treatment is effective beyond the immediate scope of its application—important though this be—appears doubtful.

All that your reporter's reading has taught him (for from practice he knows nothing), tends to the belief that infection, whether through epidemic, endemic, or contagious influences, starts and spreads, through a chemico-vital process not well understood, called fermentation. That this process requires a special seed, and then a particular climate and soil, and these in a very definite concurrence, to start infection at all. And then, enough seed being present, the degree of this concurrence between

climate and soil becomes the measure of the infection which results. Secondly, that the seeds of the various zymotic diseases, though never altogether absent from their natural haunts, are often more widely disseminated, and may be carried anywhere, with or without effect, in proportion as the due concurrence of climate and soil is or is not found. Thirdly, that the natural or artificial climate favorable to some of these diseases, occurs with some regularity during the revolution of the seasons of every year. And fourthly, far most important of all, that the soil, or pabulum vitæ, has also its periodicity, and often, if not always, approaches insidiously to pestilential activity by the way of uncleanliness and bad ventilation, fructifying the seed of an exotic or an indigenous disease, by delicate differences in its nature and character, or different concurrence with the climate.

The word "seed" used here for familiar illustration, in its common connexion with climate and soil, is not appropriate, but must be substituted by the word spore, which, though originally of the same meaning, is now applied to a stage of development much earlier in the progress of life. A seed properly defined, is that stage of advanced cell development where an embryo is recognisable, and a halt made in the progress of development begun long before; and the term is restricted to the matured germ for the reproduction of phænogamous or flowering plants. The term spore is applied to the reproductive germ of cryptogamous or flowerless plants, and instead of being an orderly organized aggregation of cells into a definite type or embryo, it is the original homogeneous body from which, upon finding the proper pabulum, the first cell is developed by imbibition from that pabulum. The cell then becomes the second step in the order of vital progression, and in some of the lower orders is the perfect being, reproducing other cells or beings by budding, and without reverting back to the spore so long as a supply of pabulum is kept up. The pabulum being exhausted, however, a spore and not a cell is produced, to be wafted about till it meets the proper pabulum in the condition for fructification, or is caught and decomposed in some of the slow combustions of nature. It next appears that these spores are not albuminous, but become so only in the second stage, or as cells; and hence, as spores, are not, like seed and cells, liable to coagulation and destruction by that low degree of heat which changes albuminous and starchy matters. Payen's

experiments appear conclusive upon this point, since he subjected the spores of the orange-colored bread-mould of Paris to a moist temperature of 248° without injury; but at 284° decomposition occurred and their vitality was destroyed. Dr. D. Child (Proceedings of the Royal Society of Great Britain for 1865) showed that living bacteriums were produced from vegetable infusions which had been boiled for ten minutes in a current of air passed through a filter of red-hot porcelain, and sealed up in glass bulbs. On the other hand, Edwards and Colin showed that the seeds of albuminous and starchy plants would not withstand a temperature of 167°, whilst the cells of cellular cryptogams, the yeast plants for example, are destroyed at a lower temperature.

Hence the reasonable, general deduction that a heat short of decomposing organic matter into its inorganic elements, though it does destroy the organisms which are in the process of active propagation, yet it does not destroy the spore, but leaves it to reproduce its kind whenever the proper conditions of pabulum recur. In this connexion, neither the experiments of Dr. Henry of Manchester, published in 1832, nor those of Von Busch of Berlin of 1851, can now be admitted to be as conclusive as they first appeared. Indeed, in the case of the latter, wherein epidemic puerperal fever occurred after six or seven months in wards from which it had been banished by a temperature of about 167°, they rather tend to confirm the view that the active ferment was destroyed, but that the spores were left to regenerate the disease as soon as the proper pabulum should have accumulated.

Heat, then, short of that required for the decomposition of organic matter, namely, about 280°, does not appear to destroy infectious poisons, except so far as it may be, and probably is, concerned in the action of all chemical disinfectants which act by that species of slow combustion involved in oxidation and deoxidation.

This, however, is far from diminishing the importance of the application of heat in its legitimate sphere as a disinfectant, but should rather serve to enlarge the sphere of its application and stimulate further research.

We have a statement very confidently made by Dr. Elisha Harris, that a judicious system of scalding the infected clothing under his direction, did protect the washerwomen and attendants from the infection of yellow fever, and from the infection of other

far more infectious maladies in twenty-four cases of these diseases which occurred in the Floating Hospital under his charge. But Dr. Harris himself is the first to guard us against drawing conclusions from so limited an experience. Since that time (1860) this experience has been extended with great advantage; but the published results met with are given in generalities, or at any rate without the systematic accuracy which should characterize such statements before they can be admitted as established facts.

Similar statements were long ago made, and are now well known, in regard to the disinfection of vessels by dry heat and by steam. Dr. A. N. Bell's account of the steaming of two vessels, and the remarkable results which followed, have been long published and are highly interesting and important, obtaining additional force as they do from instances of the application of dry heat in a similar manner which preceded them. These measures were particularly directed to yellow fever infection, but may in time be directed to cholera, ship-fever, etc., and thus by repetition and confirmation establish their results in the way in which alone they can be admitted as positive knowledge.

In concluding this very unsatisfactory notice of heat as a disinfectant, it appears necessary to say that the grounds upon which the deductions are based, and perhaps the deductions themselves, are about as unsafe substitutes for facts as disinfectants are for cleanliness; and that at present the generally received opinions in regard to heat bear about the same relation to definite knowledge that theoretical controversy does to laborious practical application. Such subjects need more persistent labor and less controversy; and your reporter pleads guilty of having talked much but done nothing, and offers himself in this, as an example of the fallacy of any such basis for knowledge, his only apology being that this least inviting part of his duty was not self-imposed.

Common chloride of lime, or bleaching-powder, as it is called, —the calx chlorinata, or chlorinated lime of the pharmacopœia,— when of good quality, is one of the very best, cheapest, and most accessible of all ordinary disinfectants for popular general uses, and has the great advantage of being already pretty generally known. It may be had in quantity for about seven or eight cents per pound, and well subserves the purpose of a deodorizer as well as a disinfectant. After having partially performed its office in a dry way, it may be moistened into a kind of whitewash, and be

applied over a broad extent of surfaces with great disinfectant and cleansing effect. Sprinkled dry over dirty floors, pavements, etc., and after a day or two washed off with water, its disinfectant properties for such purposes can hardly be overrated. Its effects are obtained through the agency of the chlorine slowly liberated, and the caustic lime it contains.

In the use of free gaseous chlorine as a deodorizer and disinfectant, it is important that it should be continuously liberated until the effect is obtained, and so slowly, and in such quantity, as not to irritate the air-passages of the inmates of occupied apartments. This object is probably best attained by the formula of Wiggers, as given in Fresenius' Qualitative Analysis. The gas is liberated from a finely-ground mixture of common salt and binoxide of manganese by means of sulphuric acid, the strength of the latter being so adjusted by dilution that the elimination is effected without the application of heat, and is neither too rapid nor too slow. Then, a definite quantity of both ingredients being taken, the effect becomes easily controlled. In the early part of the late war, your reporter, while serving on a Board of Revision for the Army Supply Table, by a slight modification of Wiggers' formula, and a little adaptation to the particular objects in view, succeeded in rendering this agent both manageable and convenient for hospital use; and the enormous quantity used during the war seems to indicate that in practical application the method did not disappoint the expectations of the Board. Indeed, the plan may be said to have come into such effective general use, that the materials may now be purchased from various manufacturing sources, and are generally accessible. Good binoxide of manganese, containing seventy to seventy-five per cent. of the oxide, can generally be had in all the principal markets. That imported from Saxony is by far the best, but our own native oxide may be used if the best qualities be selected, and the proportion of it be increased about one-third. Ashton's dry "factory-filled" common salt, and good Saxony manganese, are ground together in equal parts into a very fine powder. This forms what is called the "common salt mixture for chlorine," and can be supplied in large quantities at about fifteen cents per pound, but in small quantities would cost nearly or quite double that estimate. The other element is the "sulphuric acid mixture for chlorine," and is simply concentrated sulphuric acid, or "oil of vitriol," diluted with water

until it has a specific gravity of about 1.51 at 60°. For this strength, forty-five parts of strong acid and twenty-one parts of water are required, and the mixture must be made in a vessel not liable to be broken by the sudden heat developed by the mixing. This acid mixture must be allowed to become perfectly cold before mixing with the powder for use. The sulphuric acid mixture can be supplied in large quantities at about four cents per pound, but in small quantities at not less than six cents, and each pound measures nearly ten fluidounces. It was experimentally determined by your reporter, that 195 to 200 grains of the common salt mixture, and half a fluidounce of the sulphuric acid mixture, well stirred together, liberate within twenty-four hours about fifty-seven cubic inches of chlorine gas; and that this quantity when gradually diffused through a space of about 660 cubic feet, at no time caused pulmonary irritation or discomfort. This was therefore adopted as the convenient portion or dose which should be normal to two beds' space in hospital wards; and this was the quantity directed to be mixed in the bed-pans, and set under each alternate bed every night during the disinfection.

Tin measures were made which would hold, when struck off level full, about 195 to 200 grains of the powder, and a graduated measure served for the liquid. A pound of the powder and eighteen fluidounces of the liquid, costing from twenty-two to forty cents, give thirty-five of these portions, or enough for say thirty-five beds, for one week, under ordinary circumstances of hospital use. During epidemic influences, or with bad ventilation, much more frequent application would be needed. Besides this form, the materials were supplied in a much neater, more convenient, though more expensive form, put up in strong pasteboard boxes. One side of the box was furnished with a drawer, in which were placed 130 of the above portions, each folded in a paper, and these papers held together in bundles. The remainder of the box was occupied by a strong half-gallon, glass-stoppered bottle, containing sixty-five fluidounces of the sulphuric acid mixture duly labelled. The box itself also contains a label plainly stating the contents and mode of preparing them, and also detailed directions for use. A set of these labels are given on pages 30 and 31.

This formula and method once established, and freely published, as it was, from its very extensive use in the army, was soon adopted by manufacturers of army supplies outside of the Government

FOR THE OUTSIDE OF THE WRAPPER OF THE BOX.

CHLORINIUM.

The Materials for preparing Chlorine as a disinfectant for Hospitals, etc.

Prepared by

FOR THE BOTTLE OF DILUTED SULPHURIC ACID.

CHLORINIUM.

THE SULPHURIC ACID MIXTURE.

Take of Sulphuric Acid S. G. 1,845............................45 parts,
Water...21 parts,

Mix them carefully, and when cold put the mixture into strong bottles with accurately ground stoppers, each bottle to contain sixty-five fluidounces.

Half a fluidounce of this to be used for each package of the Common Salt Mixture.

Prepared by

FOR THE FRONT OF THE OUTSIDE OF THE PASTEBOARD BOX.

CHLORINIUM.

THE COMMON SALT MIXTURE.

Take of Common Salt, well dried..........................1800 parts.
Binoxide of Manganese, containing 72 per cent.....1875 parts.
Grind them together into a fine powder and put the powder up in packages containing about 195 grains each, and put 180 of these packages in a pasteboard box to accompany the Sulphuric Acid Mixture.

Each of these packages requires half a fluidounce of the Sulphuric Acid Mixture, and yields about 57 cubic inches of Chlorine. This quantity, when thus liberated gradually in a space containing about 20,000 times its volume of air, is borne without inconvenience by persons generally, and is not injurious even in pulmonary diseases. As very much depends upon the ventilation of apartments wherein it is to be used, no absolute rules of application can be laid down, except that it should never be used in such quantities as to produce discomfort or bronchial irritation to patients.

DIRECTIONS FOR USE.

One of the above packages or papers of the Common Salt Mixture placed in a saucer or plate and thoroughly mixed with half a fluidounce of the Sulphuric Acid Mixture, is to be placed under every alternate bed at night, and allowed to remain there three days. Upon the second night the beds which were omitted the first night should be supplied in the same way, and for the same length of time; and the whole process repeated at the end of three days or sooner according to circumstances. Should the wards be badly ventilated, or contain many sloughing wounds, or be subject to epidemic disease, or low forms of fever, the process should be continuous, that is, the mixtures should be renewed every third day. Otherwise once or twice a month may be sufficient. And, when thorough cleanliness and ventilation are attained, the process is unnecessary for occupied wards.

In disinfecting unoccupied Wards, Water Closets, Latrines, etc., by Chlorine they should be first cleansed, be closed up as perfectly as practicable, and two packages used for each 600 cubic feet of space.

Prepared by

laboratories, and thus came into somewhat general use. Upon this experience in application it is still believed by your reporter to be the best method of rendering chlorine available for disinfectant use. These boxes of "materials for chlorine" are sold by manufacturers at from $1.80 to $2.00 each, and by the druggists at $2.50 to $3.00 each.

Chlorine controlled in some such way as this, becomes one of the most convenient and manageable, as it is one of the most

effective disinfectants for many purposes. In time of epidemic cholera, or at any time when the dejections are pernicious or offensive, the portion or dose should be mixed in the close-stool or bed-pan, and be spread out as much as possible over the bottom of the vessel. Here it is allowed to stand, slowly giving off its gas, and fumigating the bed and furniture around the patient, until the vessel is required for use. It will have then given off its gas in proportion to the length of time it may have been standing, and the remainder will be retained in the residuum for utilization when and where most needed, namely, in disinfecting the dejections, and the sinks, waste-pipes, sewers, etc., into which the dejections are emptied. When the dejection is passed into the vessel, the residuum being thick and tenacious, will, in order to secure the best disinfectant effect, require stirring up to incorporate it with the dejection. This may be done with a short stick kept in the close-stool or bed-pan for this purpose (and to mix the chlorine materials with), the stick to be held in the hand while the vessel is receiving the dejection, and to be cleansed and returned with the vessel to the bedside, where a fresh portion of the materials is at once mixed and spread over the bottom of the vessel to stand in readiness for the next dejection. The warmth of the dejection, when passed into the residuum, hastens the reaction by which chlorine is set free, and this exactly at the time when it is needed, so that a residuum which may have been standing so long as to have liberated all the chlorine that could be set free at the ordinary temperature of the vessel, is by the increase of temperature at once awakened into new activity, and yields a sufficient additional quantity of the chlorine just at the time of greatest need. The disinfectant, then in a state of activity, goes with the infected matter into the sewer; and as no dejections go into the sewer without the corrective, the water-closets, sinks, and sewer all soon experience the benefits, while the rate of disinfection goes along parallel with the necessity, increasing or diminishing with the number of dejections. Besides this, as the dejections increase in frequency in any given case, the residues are used in quicker succession, and while containing more chlorine, and this without reducing the quantity liberated in the apartment. The reactions by which the chlorine is set free in this process, form sulphate of soda, and sulphate of the protoxide of manganese which, with the excess of sulphuric acid, are all actively disin-

fectant, as well as the chlorine; and the whole result is, therefore, utilized with about as little trouble, expense, or complication, as can be reasonably expected from the use of any similar agency. Indeed, it can hardly be possible that this plan, in practical application, if well carried out, should not yield excellent results for all such special uses; and a prominent quality inherent to it is, its susceptibility of being easily contracted to the scale of any ordinary sick-chamber, or expanded to fit the greatest emergency, by the exercise of but a little common sense.

If, however, as too often happens, the successful application of any agent in its proper sphere be allowed to mislead in the direction of applying it to more general or less appropriate uses, the best interests involved are sure to be sacrificed to a corresponding extent thereby. Hence this plan, though well adapted here, would be entirely inadequate to very many of the other uses of disinfectants—thus well illustrating the important fact that the discrimination necessary to a successful application of the various well-known means of disinfection, is often the only thing wanting. It has come within the observation of your reporter to see attempts at disinfection by chlorine, which through a want of this discrimination were nugatory, though troublesome, expensive, and even dangerous; where a good smoky wood-fire, made in any reasonable way at the point where the chlorine was liberated, would have been far more effective, and cheaper, more simple, and much more easy of application.

Indeed, for the disinfection of empty tenement-houses, hovels, stables, cellars, etc., under many circumstances of not infrequent occurrence, there are few more effective agencies than wood-smoke, diffused by the heat of the fire from which it is produced. This smoke carries carbon, creasote, pyroligneous acid, carbonic acid and oxide, and other products of the imperfect combustion, with watery vapor enough to dissolve or suspend them, and with heat enough to secure their rapid diffusion and safe transportation until condensed by contact with the cooler surfaces upon which they are finally all deposited in one form or another. Every part of the air-space is thus invaded, and every surface receives its due share of the condensed product with that certainty which characterizes the operation of the natural laws involved.

A good smoking, followed by a good whitewashing, is as thoroughly disinfectant and antiseptic and curative to all surfaces

and objects to which it can be thoroughly and properly applied, as the same treatment is to a ham; and there is no more reason for omitting to use such treatment when appropriate, than for curing hams by ozone.

A very large proportion of the uses for disinfectants, however, cannot be well subserved by either of the agencies yet alluded to. Damp, underground apartments, alley-ways, cesspools and privy-sinks, empty or full, sewer-traps, water-closets and urinal basins, garbage receptacles, dirt-piles, and, in short, most of the insalubrious places not accessible to copious washing or other cleansing processes, are often best disinfected by some drying and absorbent substance or powder; and if such substances possess chemical or physical properties whereby the sources of insalubrious effluvia are changed, at the same time that their emanations are absorbed and fixed, so much the better. Prominent among such substances stands lime—common quick-lime. A dark, damp, mouldy, ill-conditioned, bad-smelling room or closet may be rendered comparatively harmless by keeping in it a bucketful or two of lump lime, and renewing this as it falls to powder; and in this way, or when powdered, or in a liquid form, as whitewash, lime is perhaps as susceptible of important uses as a disinfecting or cleansing agent as any other substance known. As an absorbent of aqueous vapor it stands preëminent; and when it is remembered that the aqueous vapor of the atmosphere is the great solvent and vehicle for carrying noxious effluvia and decomposing organic matter, it will not be difficult to understand an important characteristic of lime as a disinfectant. To its affinity for water, for carbonic acid, for sulphur compounds, and for acids in general; to its caustic nature as destructive of the lower orders of organic life; to its saponifying action upon all oily or greasy matters, and to its slow solubility whereby its action is rendered persistent and durable, does lime owe its chief efficiency as a disinfectant; and these characteristics duly considered, will lead any mind of ordinary intelligence to the proper indications to its uses.

One of the great drawbacks to the very free use of lime at present is its very high price. Good lime cannot now be had at less than $2.30 per barrel in large quantities, or $2.40 in small quantities of one to five barrels. The barrels are small, and contain from 190 to 230 pounds each, averaging about 205 pounds, making the prime cost nearly one and a quarter cents per pound.

Then, as it is by far best adapted to disinfectant purposes when in the form of powder, it will cost say not less than one cent per pound additional for porterage, grinding, and repacking. This repacking must be done in other barrels—say second-hand flour-barrels, because the original lime-barrels are worthless to carry a powder in. This, again, increases the cost by about one quarter cent per pound; so that the net cost of lime properly ground, and put up for sanitary purposes, would be about two and a half cents per pound, each barrel of the powder containing about 300 pounds. If done upon a very large scale, or at the kilns where the lime is made, this estimate would include a sufficient manufacturer's profit, and still secure the proper quality of lime. But in any moderate quantities, with due regard to the proper quality and management, another quarter of a cent per pound would have to be added for manufacturer's profit, making the net cost say two and three-quarter cents per pound, or $55 per ton, including barrels, cooperage, and the expenses of delivery. Thus prepared, it might with utility and propriety be distinguished as Sanitary Lime—meaning, of course, lime well adapted to sanitary purposes. Well put up in paper-lined barrels, and stored in a dry place, it would probably keep well for some time, without risk of bursting the barrels. For many uses the disinfectant value of such a powder could not be excelled, nor its place be as well supplied by any other agent.

Another disinfecting agent of somewhat similar character, and scarcely less important, is found in common wood charcoal. Lowitz was among the first to demonstrate its peculiar effects upon offensive smells; and long before the researches of Stenhouse, its properties were pretty well known. It is a most powerful and wonderful absorbent of almost all the offensive and noxious gases, and, unlike lime, performs its office as such, for the most part, independent of aqueous vapor, though a good absorbent of this vapor also. It packs away the gases within its pores in some unknown way, so that it is capable of taking up and retaining, under favorable circumstances, fifty to ninety times its volume of some gases; but under the ordinary circumstances of practical use this absorbent capacity is very much reduced. The absorbent properties of charcoal are generally attributed to the effects of surface adhesion (which, in itself, is hardly more than an expression of ignorance). For instance, Mitscherlich calculated

that the cells constituting a cubic inch of boxwood expose a surface of not less than seventy-three square feet. Now when this boxwood is converted into charcoal, by driving off everything except the intractable carbon, this latter, since it does not fuse, retains the cellular structure, and becomes a perfect skeleton of the wood, leaving the enormous cell-surface not materially diminished, but freely accessible to outside contact of gases and vapors through the channels opened by the volatile portions which escape in the process of charring. This seventy square feet of surface absorbs, attracts, or condenses different gases in different proportions or quantities, but, singular to say, in very nearly the proportion of their solubility in water. It also attracts them in groups as well as singly, and free from aqueous vapor as well as combined with it. But it is a fact very damaging to this surface-adhesion theory, that the quantity of at least one gas thus absorbed is so great, that if reduced to the liquid state by pressure, its volume as a liquid would exceed that of the charcoal which would absorb it. Hence, the ultimate atoms of such gas must be nearer together in the pores of the charcoal than they are in the liquid state—a circumstance difficult to realize and impossible to explain.

It is, however, not only as an absorbent that charcoal performs its disinfectant functions. In common with spongy platinum and some other substances, it has the power of inducing chemical action by increasing the natural affinities of certain elements; and its prime quality in this respect, and that upon which its disinfecting properties probably chiefly depend, is that of oxidation, or a combustion with heat, but without light. It appears to store up the oxygen in its caves and pores, nourishing up this giant into that condition of activity which is so peculiar and characteristic as to have required the new name—ozone. This active oxygen (nascent oxygen or ozone) seems to lie in wait, hidden in the pores and recesses of the charcoal, and whenever any weakly or loosely-compounded gas or vapor comes along, invited or impelled by the absorbent power of the charcoal, the greedy giant pounces upon it and gobbles it up. Thus sulphuretted hydrogen, absorbed by charcoal, has its hydrogen at once seized by the oxygen and converted into water, whilst the sulphur is precipitated in a harmless condition, or oxidized into sulphurous or sulphuric acids. Carburetted hydrogen is decomposed and oxidized into carbonic

acid and water; and such reactions probably continue by fresh accessions of oxygen from the air without, until the capacity of the charcoal for the gases and mixed products is saturated.

Then, as far as disinfection is concerned, the charcoal has returned to the condition of wood, its cells being refilled with volatile matters, and requiring reheating to renew its powers. In all these wonderful and inscrutable effects, the charcoal itself appears to undergo no change nor to suffer any waste. However effective it may be, it is but passively so, preserving that unchanging indestructibility illustrated in the carbonaceous inks of Herculaneum, which have withstood the vicissitudes of two thousand years. In whatever way the action of charcoal as a disinfectant and antiseptic may or may not be explained, the truth that it is so, to a most remarkable extent, is both well known and well established through that safest and best of all teachers—time. Dr. Ure mentions that oak stakes were found in the bed of the river Thames, which, on the authority of Tacitus, are shown to have been placed there probably by the Britons when defending themselves against an invasion of Julius Cæsar. The stakes had been charred on the surface, and had thus not only retained their form, but the charring had perfectly preserved the wood within in a firm, sound condition. Almost the entire city of Venice is built upon surface-charred piles; and your reporter slept very soundly over the heads of these old piles, with more confidence in the antiseptic powers of charcoal than is common in these days of novelties. Thus the history of ages long past is both written and preserved foı us through this agency, and the monuments and architecture which verify and illustrate this history are themselves based upon this same antiseptic power. It seems not a little curious then, that it should be considered useful to rehearse and advocate the antiseptic and disinfectant properties of charcoal to an intelligent profession at the present day, as if they were new or strange; or as if your reporter could add a single atom to the accumulated knowledge of the past. It has been long thoroughly well known that dead animals and vegetables in a state of putrefaction, and vats of organic liquids in a state of fermentation, when covered with powdered charcoal, have their processes arrested and their order of progression entirely changed. In the case of the animal and vegetable matters the disintegration goes on, but the quality of the process

is entirely changed. The gases and vapors given off as the mere volatile portions pass away, are odorless and comparatively harmless; while the more fixed and the inorganic portions innocently return to dust. The putrefactive fermentation which yields noxious products is changed by its contact into a slow combustion, which yields the products of combustion only, namely, carbonic acid, water, oxides of nitrogen, and ashes.

This certainly is all that can be necessary to indicate to common intelligence the value of charcoal as a disinfectant. Its peculiar adaptations in use will always flow from a very little reflection upon its properties; and a little cultivation of the knowledge of these properties, will prepare any moderately educated mind to recognise the special indications to its use at the time of need.

Sanitary Charcoal (your reporter proposes this title for it) should be freshly burned—be ground into a moderately fine powder, and be packed in good paper-lined flour-barrels, with the least practicable exposure to air and moisture in the process. It will then possess its maximum ordinary efficiency, and will retain this condition almost indefinitely. In large quantities, common charcoal now sells at about one dollar per barrel, and the contents of a barrel, as sold, will weigh from sixty to eighty pounds, according to the moisture it contains. But when dried for powdering, the same contents will not weigh over forty to fifty pounds. It will then cost not less than one cent per pound to powder it properly, and half a cent additional for barrels, packing, and delivering. This would make a total net cost of say three and a half cents per pound, to which would have to be added a manufacturer's profit proportionate to the scale of production, say one-quarter cent per pound, making a total value in first hands of say three and three-quarter cents per pound, or seventy-five dollars per ton in barrels of about one hundred and twenty-five pounds each, delivered.

A due consideration of the multitudinous uses for disinfectants, leads your reporter to the belief that many of these uses would be best subserved in special application by some judicious combination of lime and charcoal. This, in the manner and proportion now to be proposed, has never, so far as your reporter knows, been tried in any public way, though the association of the two substances for this purpose is by no means new. The formula

used by the British Sanitary Commission in the Crimean war (see Report, p. 144), was one part of peat charcoal, one part quicklime, and four parts sand or gravel; but the character and quantity of the last ingredient seems to indicate, in the absence of direct information on this point, that the mixture was not ground together, a point which, *à priori*, would seem of some importance, since the prominent utility of the association is that the lime and charcoal may keep each other in the condition of greatest efficiency, a point which can only be secured by a very intimate mixture in a state of powder. It may have been that the lime and peat charcoal were powdered together, and then the sand and gravel used as a diluent, since the Commission remark that charcoal loses its effect when wet, while lime gains efficiency by moisture; and the common-sense deduction from this experience would be, that by grinding them together the lime would serve to keep the charcoal dry, and in so doing would itself gain efficiency. However this may be, certain it is that the use of lime and charcoal together, for disinfectant purposes, is neither new nor unsupported by practical application on the large scale; and the mere varying of the proportions, and of the kind of charcoal, and the proposal of a name for the mixture, is but the appropriation of other people's ideas, as soon as they become worth appropriating, in a new dress, and under a new title, with this disadvantage, that the accumulated experience in regard to the old mixture must in a measure be sacrificed to the theoretical, or *à priori* reasoning of the new. An experimental observation, in order to be accurate and reliable, must commence anew upon the new basis. Nevertheless, upon the testimony of the British Sanitary Commission, carefully guarded and equivocal as that testimony is, and upon the circumstance that peat charcoal is not easily accessible to us, and is much inferior in charcoal value to our common wood-charcoal, and lastly upon purely theoretical grounds, your reporter recommends the trial of modified materials in a different proportion from those hitherto adopted; and suggests as a convenient name for this mixture, that of "Calx Disinfecting Powder," or, more briefly, "Calx Powder," the sole aim of which is better to combine the advantages and cleansing effect of lime and charcoal under a more definite formula and name. The proportion in which the two agents should be mixed must, for the present at least, be determined by a mere act of judgment, and it is upon

this basis, and this alone, that the proportion of four pounds of lime to one pound of dry charcoal is advised. This gives a proportion by volume of pretty nearly equal measures, and yields a fine grey powder of a sabulous character, convenient enough for general use.

This powder attracts moisture so rapidly, and with such avidity, and increases so much in bulk by this slaking of the lime, that a bundle of it containing a pound tied up in double paper, in lying for a few days undisturbed upon an office-table, burst the papers, and was found to weigh one-fourth more than when first tied up. The heat evolved in this absorption of moisture is very considerable, and a very important element in the efficiency, since it not only serves to create a constant commotion in the air around the powder, bringing fresh and fresh portions of air into immediate contact with the powder, and discharging this air upwards, dried, rarified, and purified; but this heat also coöperates with the desiccating effect of the lime upon the charcoal, quickening and renewing both its chemical and its absorbent action. Hence, the Calx Powder, in common with the Sanitary Lime and Sanitary Charcoal, must be kept as much as possible out of contact with air and moisture when not in use, and spread out with as great a surface of contact as possible when in actual use. Hence, the surface exposed, rather than the absolute quantity used, becomes the measure of the effect produced; whilst the thickness of the stratum in which they are exposed only increases the effect in proportion as it may be from time to time stirred up for the exposure of new surfaces, until the whole quantity in use is spent or saturated. The economy in management of these agents thus indicated operates both upwards and downwards, cleansing equally the surfaces upon which they rest, and the air above them. It is a cardinal rule in the use of all such disinfectants as these that they should be applied directly upon the sources of infection; otherwise they become mere dryers and deodorizers, expending their force upon the comparatively useless object of disarming and concealing the smoke, while the fire is left to burn on.

Should this Calx Powder be found to combine the useful properties of its components with the expected advantages over their separate use, it may probably in time become a suitable counterpart to the common chloride of lime in popular use, and at any rate furnish an efficient alternate free from the odor which is

sometimes a serious objection to the chloride. From the smuttiness given by the charcoal, it is however less cleanly in application than lime alone or the chloride, though generally more effective.

This mixture would probably cost, if prepared on the large scale, say three cents per pound or sixty dollars per ton, well put up in good barrels, and delivered in first hands. This is very considerably less than half the present cost of good chloride of lime, at the same time that it is well calculated to subserve many of the most general and important uses of the latter agent

A specimen of this powder, but with only about half the proportion of charcoal proposed, is presented with this report; and two barrels of the same powder, containing say three hundred pounds each, are placed at the disposition of the Academy, and will be delivered free of expense wherever the Academy shall direct. One barrel has already been sent to a large hospital where it will be fairly tried.

In conclusion and summary your reporter presents the following propositions for adoption by the Academy:

First.—That cleanliness and ventilation are the only true disinfectants; and that all agencies are disinfectant in proportion as they promote or tend towards cleanliness and ventilation, whether by chemical or mechanical action.

Second.—That mechanical disinfection by scavenging* should always precede all other means.

* "Scavenging." This word is coined; and upon Ben Jonson's authority it must not be forgotten that "A man coins not a word without some peril and less fruit; for if it happen to be received, the praise is but moderate; if refused, the scorn is assured." Scavenging is obtained from scavenger, upon the ground that need sometimes justifies the making of a verb from a substantive. Scavenger is an English word derived from the Anglo-Saxon verb *scafan*, to shave, to scrape, and is defined by Worcester as "a person who clears away filth or litter from the streets;" and the definition is given on the authority of Bishop Hall. It is now proposed to go back and form a verb *to scavenge* upon the noun scavenger; and the apology and reason for this is that there is an apparent need growing up for a single word which will express the simple act of cleaning away filth in the sense of scraping it up, or off, and removing it entirely away, for purposes appertaining to the public health and comfort. The verb *to clean* does not appear to take this comparatively new meaning properly within its scope, since a scavenger does not simply mean one who cleans. For example, it might be said that a house had been well cleaned, but was not scavenged. That is, the filth had been carefully removed from walls, floor, closets, etc., but accumulated in the sinks, sewers, barrels, boxes, etc., from whence the scavenger should take it by a distinct action.

Third.—That the greatest mechanical cleanliness and ventilation having been attained, the object of next importance is a proper discrimination in selecting that special chemical agency best adapted to the special end in view.

Fourth.—That there are special well known agents in abundance within the compass of the present state of knowledge, that are adapted to all the legitimate purposes of disinfection.

Fifth.—That of all special agencies heat is the most important, because most effectual, and most generally applicable in preventing the spread of infectious diseases by ferments.*

Sixth.—That the special agency of the second rank in importance is chlorine, because most effectual and most accessible for hospital purposes in disinfecting dejections; and the effluvia arising from sources which, from their relations to human life, cannot be positively controlled, as the effluvia from ulcers, wounds, and diseases.

Seventh.—That the special agents which rank next in importance, from the wide scope of their general applicability to the common purposes of life, are first, lime; second, a mixture of lime and charcoal; and third, charcoal.

Eighth.—That lime and charcoal, or any mixture of them, to be well adapted to hygienic or sanitary uses, require a special preparation and preservation which is simple and easily obtained. And that these agents when so prepared may be advantageously distinguished by the names sanitary lime, sanitary charcoal, and any mixture of the two as calx powder.

Ninth.—That among the special agencies for disinfecting empty cellars, tenement-houses, stables, and other confined spaces, the smoke and products of imperfect combustion from a fire of hard or green wood, deserve special consideration from their combined efficiency, economy, and simplicity.

Finally, your reporter begs to offer a word of caution in regard to the already numerous and still increasing number of patented and vaunted disinfectant powders and liquids. These are generally more or less complex compounds of the various well known agents, the prime object of which is to make money easily and rapidly. And this object is not unfrequently sought

* This word ferments is here used as a substitute for fomites, which should now be given up as inexpressive and incorrect in its application to the propagating cause of zymotic diseases.

through the endorsement of bodies like this Academy, and the association of its name with *ad captandum* statements.

All of which is respectfully submitted to your Committee by

EDWARD R. SQUIBB, M.D.

BROOKLYN, May 28, 1866.

Accepted and adopted by the Committee on Hygiene and Public Health, May 28, 1866, and ordered to be presented to the Academy at its special meeting to be held May 30, 1866.

Accepted and adopted by the Academy, May 30, 1866, and ordered to be printed.